

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Appln. No. 10/787,406

AMENDMENTS TO THE DRAWINGS

Please enter the following changes to the drawings.

Figs. 1-3C and 5-10 have been amended to include appropriate cross-hatching for the various layers. No new matter is added.

Reconsideration and approval of the proposed drawing changes and acceptance of the eight (8) sheets of replacement sheets are respectfully requested.

Attachment: Annotated Marked-Up Drawings (Figs. 1-3C and 5-10)
Replacement Sheets (Figs. 1-10)

REMARKS

Claims 1-13 are all the claims pending in the application, including new claims 11-13. Review and reconsideration on the merits are requested.

Formal Matters

Applicants appreciate that the Examiner has acknowledged the claim for foreign priority and further confirmed receipt of the certified copies of the priority documents. This application is a regularly filed national application pursuant to 35 U.S.C. § 111(a), but is not a National Stage application.

Objection to Drawings

In response to the objection, Applicants submit herewith corrected drawings showing appropriate cross-hatching for the various layers in Figs. 1-3C and 5-10. Withdrawal of the objection and acceptance of the replacement sheets is kindly requested.

Claim Amendments

Claim 1 has been amended to recite that the filling material 23 comprises a resin. Support is found, for example, at page 22, line 24 - page 23, line 3. Claim 3 has been amended to further characterize the conformal vias as having a hole wall, a metallic material arranged along the hole wall, and a resin material filling the remaining portion of the hole. Support is found, for example, at page 6, lines 19-21 of the specification. Claim 5 has been amended to correct an inadvertent error. Similar to claim 3, claim 9 has also been amended to further characterize the conformal vias. New claim 11 depending from claim 1 recites that the cylindrical through hole conductor is formed on an inner circumference of the through hole as

clearly shown in the drawings. New claims 12 and 13 depending from claims 8 and 9, respectively, recite that the filling material comprises a resin.

Entry of the amendments is respectfully requested.

***Response to rejection of Claims 1-5 and 7-9 Under 35 U.S.C. § 102(b) as being anticipated by
U.S. Patent No. 6,281,446 to Sakamoto***

Sakamoto was cited as disclosing in Fig. 1 a wiring substrate in which a wiring stacked portion (11) including a conductor layer and a resin layer is stacked on a principal face of a core substrate (13) including a substantially cylindrical through hole conductor (14). Sakamoto was further cited as disclosing Applicants' claimed connection portion composed of via conductors buried in the resin layer which bring the cover-shaped connection portion and the terminal pad conductor into conduction, where the via conductors constituting the connection portion are not provided above a center axis of the through hole, and further, where the via conductors are not provided above the filling material in the through hole conductor (claim 2).

Applicants traverse, and respectfully request the Examiner to reconsider for the following reasons.

Claim 1 requires a substantially cylindrical through hole and a filling material filling a hollow portion of the through hole, where the inner periphery of through hole 21 is lined with through hole conductor 22 and the hollow portion of through hole 21 is filled with filling material 23 (Fig. 1). The through hole of the present invention is therefore different from via-hole conductors 14 of Sakamoto formed in the through holes of the substrate 12, where the via-hole conductors are IVH conductors. In the IVH structure, the electric conductors are formed by filling electrically conductive materials into the IVHs. See col. 1, lines 35-37 and col. 4, lines 5-

10 of Sakamoto. The IVH structure of Sakamoto is contrasted to "old" multi-layer circuit boards, where wiring layers are electrically connected with each other by conductors plated on the inner wall of a through hole formed by drilling. See col. 1, lines 26-30 of Sakamoto.

To clearly distinguish the invention from Sakamoto, claim 1 has been amended to recite that the filling material comprises a resin, whereas in Sakamoto an electrically conductive material is filled into the IVHs 14. Because the through holes of Sakamoto do not have a filling material comprising a resin filling a hollow portion thereof, Sakamoto is not prone to the problem of the resin filling material having a larger coefficient of thermal expansion than that of the through hole conductor 22 as shown in Figs. 3A to 3C. Thus, there is no corresponding problem to fix in Sakamoto which would lead one of ordinary skill to the present invention.

Present claim 3 requires "conformal" vias. As defined in the specification, a "conformal" via is formed by arranging the metallic material along the hole wall and burying the remaining portion with a resin material (page 6, lines 19-21 of the specification). Clearly, the via-conductors of Sakamoto are not "conformal" vias. Claim 3 has been amended to more clearly reflect this difference, namely, to recite that the via conductors are conformal vias having a hole wall, a metallic material arranged along the hole wall, and a resin material filling the remaining portion of the hole. Conformal vias are contrasted with the filled vias of Sakamoto at page 6, lines 16-19 of the specification which are filled up with a metallic material.

Claim 5, which requires the via conductors on a side of the terminal pad conductor to be further spaced from a center axis of the through hole than the via conductors on a side of the cover-shape conductor portion, is also not met by Sakamoto. Particularly, in Fig. 1 of Sakamoto,

the via conductor connected to the terminal pad 22 and the third layer from the bottom is closer to the center axis of through hole 14 (formed in the first layer from the bottom) than the via conductor constituting the "connection portion" in the second layer from the bottom.

Claim 8 which requires a substantially cylindrical through hole conductor formed on an inner circumference of the through hole and a filling material filling a hollow portion of the through hole conductor distinguishes over the IVH via-conductor 14 of Sakamoto. Claim 9 is similar to claim 8, but recites that the connection portion is composed of conformal vias which further distinguish the multi-layer wiring board of Fig. 1 of Sakamoto.

The problem solved by the invention, which is not encountered with the wiring board of Sakamoto, and therefore indicative of the unobviousness of the invention, is summarized below as follows.

The significance of providing a transmission line structure where the via conductors 71 and 72 composing the connection portion 7 avoid positions above the center axis 211 of the through hole 22 (see Fig. 1 of the present specification), is discussed at pages 4-6 of the specification. More specifically, as shown in Figs. 3A-3C, thermal expansion of the through hole conductor 22 is smaller than that of the surrounding resin materials 23 and 25. In case the wiring resin substrate is cooled, on the other hand, a reverse phenomenon occurs so that the shrinkage of the filling material 23 is concentrated in the vicinity of the center axis 211 of the through hole 21, as shown in Fig. 3C, to pull down the overlying cover-shaped conductor 4 and resin layer 3. Therefore, via conductors 61 and 62 are easily influenced, if they lie over the center axis 211 of the through hole 21, by the influences of the push-up or pull-down of the core

substrate. That is, in accordance within the invention as claimed in claims 1, 8 and 9, the influence of the aforementioned push-up/pull-down from the core substrate can be prevented by arranging the via conductors constituting the connection portion at positions avoiding the center axis of the through hole. In comparison, the wiring substrate of the related art has been unable to avoid the push-up/pull-down problem because the via conductors are arranged above the center axis of the through hole so as to make the wiring highly dense.

For the above reasons, and in view of the amendment to the claims as discussed above, it is respectfully submitted that claims 1-5 and 7-9 are not anticipated by Sakamoto and withdrawal of the foregoing rejection under 35 U.S.C. § 102(b) is respectfully requested.

Response to rejection of Claim 6 Under 35 U.S.C. § 103(a) as being unpatentable over Sakamoto

The Examiner recognized that Sakamoto fails to disclose a connection portion having a stacked via structure, in which a plurality of filled vias are substantially concentrically contiguous to each other at positions other than that above the through hole. However, the Examiner considered that it is known in the art to form a stacked via structure wherein the vias are substantially concentrically contiguous to each other.

Applicants rely on the response above with respect to the rejection of claims 1-5 and 7-9 over Sakamoto above.

Response to rejection of Claim 10 Under 35 U.S.C. § 103(a) as being unpatentable over Sakamoto in view of U.S. Patent No. 5,951,917 to Nayak

The Examiner recognized that Sakamoto fails to disclose that the center axes of the via conductors are spaced by 50 μm or more and 300 μm or less from a center axis of the through hole. However, the Examiner considered that such a via pitch is well known in the art.

Applicants rely on the response above with respect to the rejection of claims 1-5 and 7-9 over Sakamoto. Regarding the secondary reference, Nayak does not make up for Sakamoto's deficiencies.

Summary

Sakamoto does not meet the structural feature of claim 1 which requires a substantially cylindrical through hole and a filling material filling a hollow portion of the through hole, where the inner periphery of the through hole 21 is lined with through hole conductor 22 and the hollow portion of the through hole 21 is filled with filling material 23.

Claim 1 further differs from Sakamoto in that the filling material comprises a resin.

Claim 3 requires "conformal" vias which are not met by Sakamoto.

Claim 5 which requires the via conductors on the side of the terminal pad conductor to be further spaced from the center axis of the through hole than the via conductors on a side of the cover-shaped conductor portion is also not met by Sakamoto.

Claim 8 which requires a substantially cylindrical through hole conductor formed on an inner circumference of the through hole and a filling material filling a hollow portion of a through hole conductor is not met by Sakamoto.

Claim 9 is further distinguished from Sakamoto in that it requires "conformal" vias. For the above reasons, the present claims are not anticipated and define novel subject matter.

Moreover, it is respectfully submitted that the claims as amended herein are patentable over Sakamoto, considered alone or in combination with Nayak. Particularly, there are certain problems peculiar to the type of wiring substrate of the invention, and there is no corresponding problem to fix in Sakamoto which would lead one of ordinary skill to the present invention.

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Moreover, the differences in structure between the invention and Sakamoto are material, unobvious differences as discussed above.

Withdrawal of all rejections and allowance of claims 1-13 is earnestly solicited.

In the event that the Examiner believes that it may be helpful to advance the prosecution of this application, the Examiner is invited to contact the undersigned at the local Washington, D.C. telephone number indicated below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



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 Q80151
 Group Art Unit 2841
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 For: WIRING SUBSTRATE
 Annotated Sheet

FIG. 1

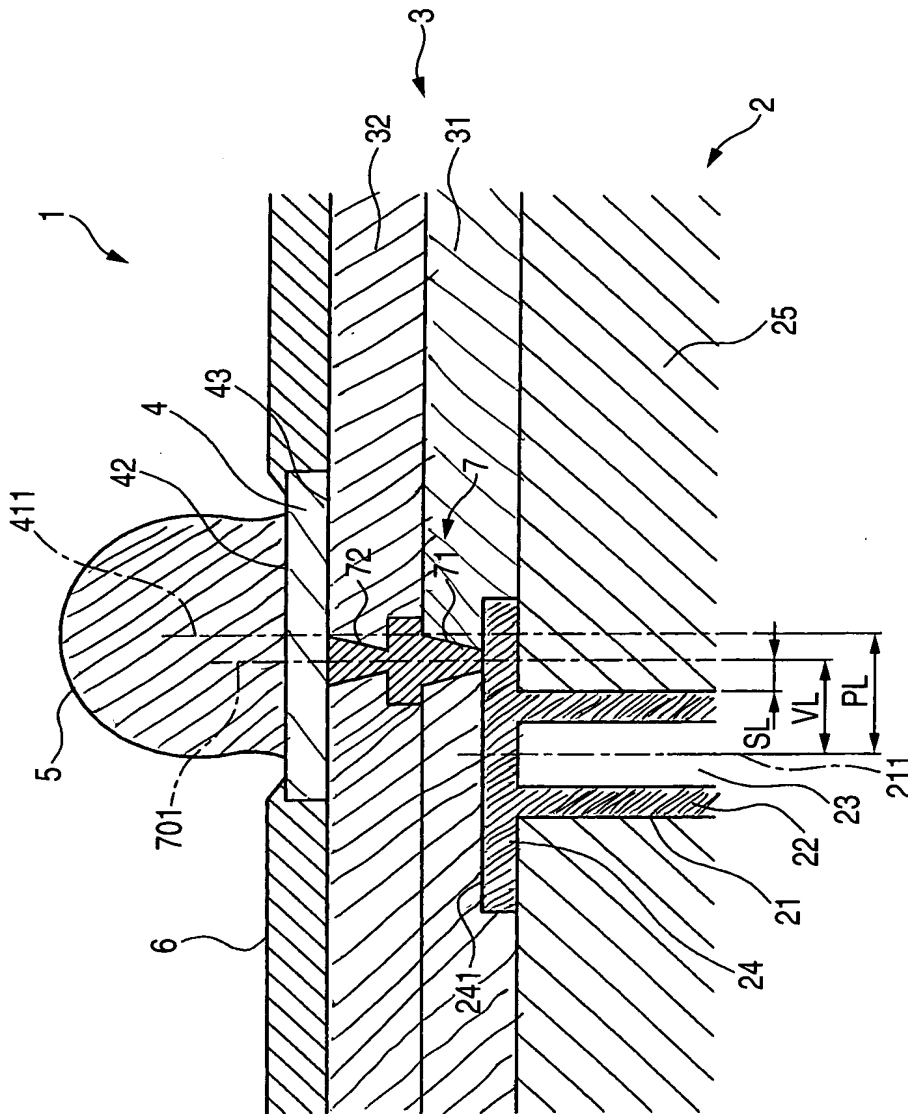


FIG. 3A

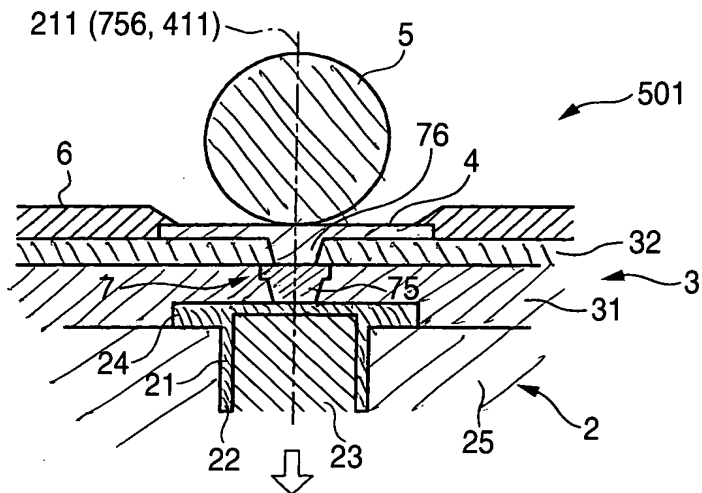


FIG. 3B

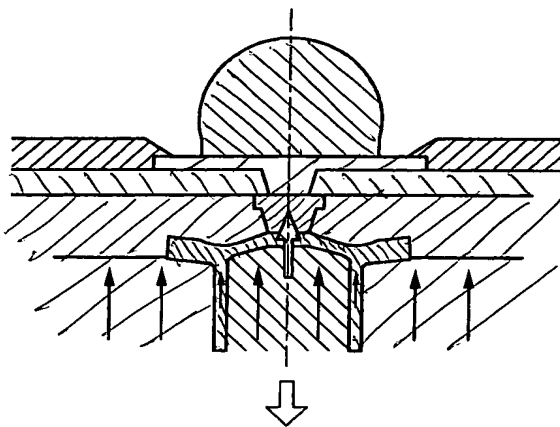


FIG. 3C

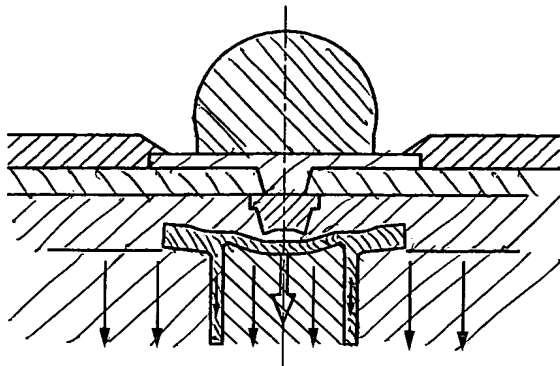


FIG. 6

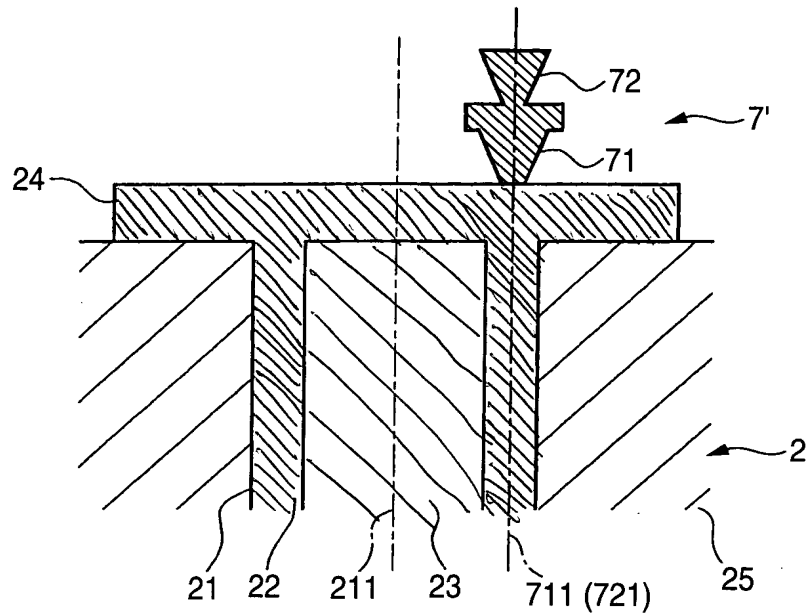


FIG. 7

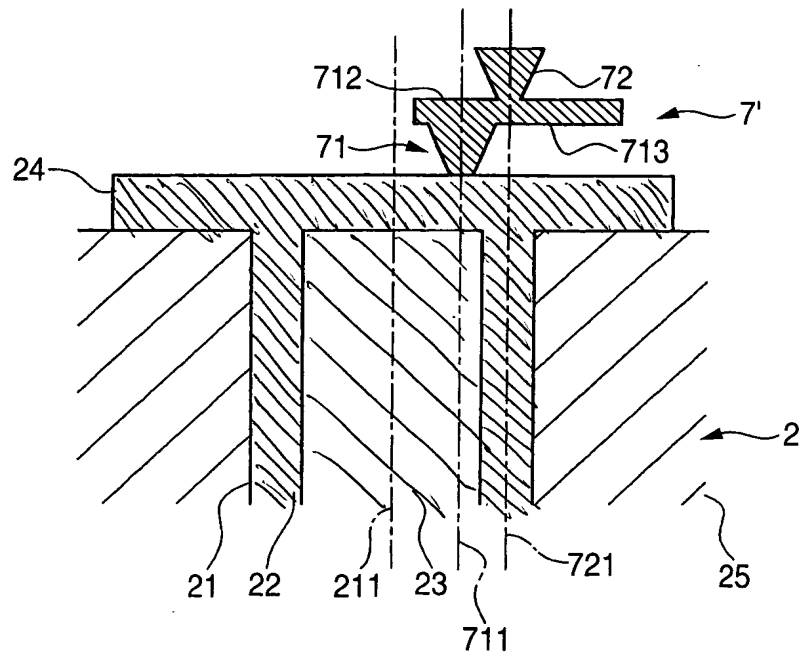


FIG. 8

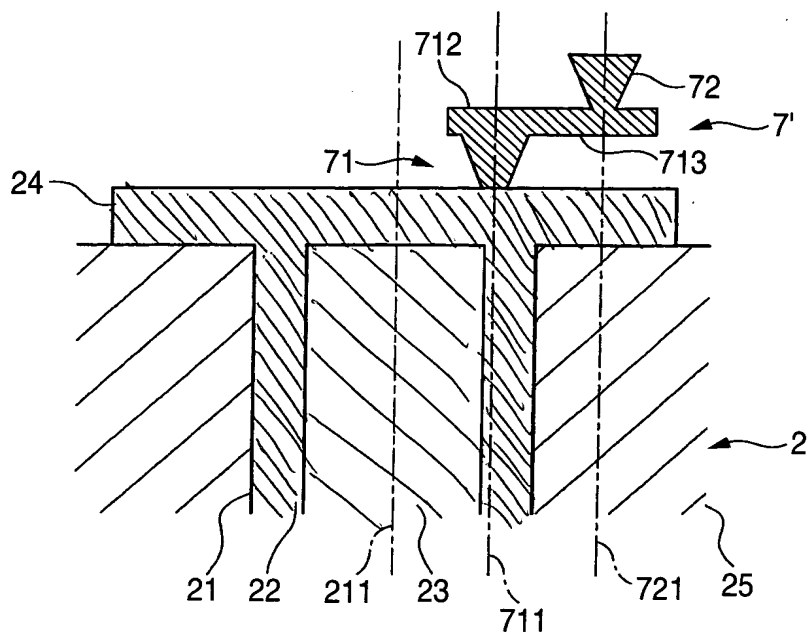
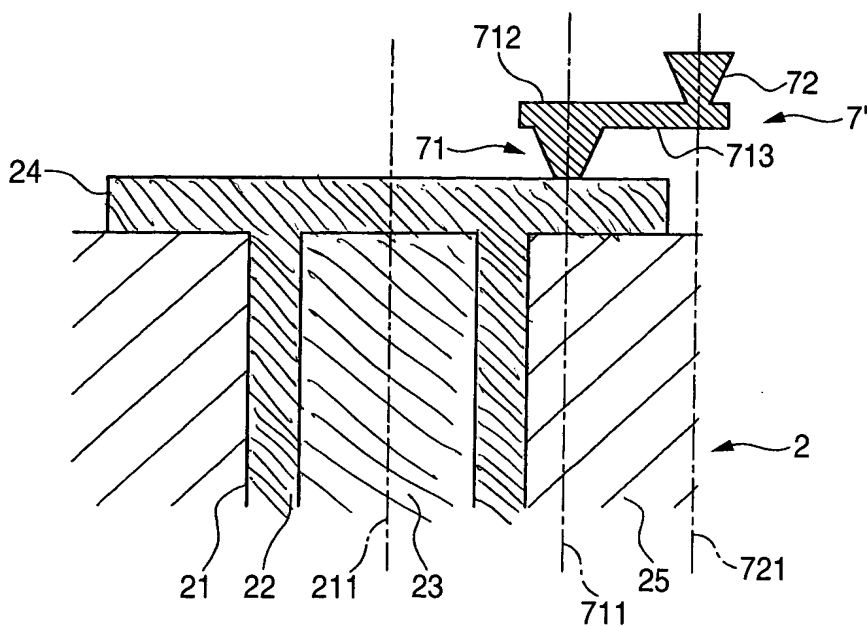


FIG. 9



This cross-sectional view shows a substrate 2 with a series of layers 21, 22, 23, and 24. A dome-shaped structure 5 is formed on the surface, with a top layer 4 and a base layer 6. The dome is surrounded by a ring-like structure 3. A central opening 7 is present in the dome. A vertical dimension line labeled PL indicates the height of the dome. Other labels include 201, 411, 42, 43, 31, 32, 33, 71, 72, 73, 711, 721 (723), and 211.